Mercy." The polarity of the magnetic needle would become known to the Chinese of that city and its neighbourhood first. The first who noticed the polarity would be some intelligent person who communicated the fact as an unaccountable peculiarity in an age when omens and portents were diligently sought for in every natural object and phenomenon.

The earliest author who mentions the "south-pointing needle" lived in the fourth century B.C. There can be no reasonable doubt that the polarity of the needle was known at that time. The discovery of the fact must have preceded the invention of any myth embracing it. As to the discovery, there is no reason to suppose it was in any way foreign, because the Chinese use an enormous number of needles, and have an inexhaustible supply of ironstone. But though the polarity was known, it was not turned to a practical use till the Tsin dynasty, when landscapes began to be studied by the professors of *fengshui*, or geomancy. There was at that time a general belief in the magical powers of natural objects. This was a Buddhist doctrine, and it took firm hold on the Chinese mind of that age. The Chinese philosophers of those times taught that indications of good and ill luck are to be seen all through Nature. The polarity of the needle would take its place in this category of thought. Though it is not distinctly mentioned by writers of the fourth century, yet to their disciples it became an essential part of the landscape compass which the professors of *fengshui* all use. Kwo Pu, the founder of this system, died A.D. 324, and it was not till four centuries later that the *fengshui* compass began to assume its present form. The compass used by the professors of geomancy for marking landscape indications was first made about the eighth century. It was of hard wood about a foot wide, and it had in the centre a small well in which a magnetized needle floated on water. On the compass were inscribed several concentric circles, as on the wooden horizon of our globes. They embrace the twelve double hours, the ten denary symbols, eight diagrams, and other marks. This compass was used in preparing a geomantic report of any spot where a house or tomb was to be constructed, so that the construction might not be upon an unlucky site or planned in an unlucky manner. At the same time there was living a Chinese who had studied Hindoo astronomy, and was the Imperial astronomer, and also a Buddhist priest. He noticed that the needle did not point exactly north, and that there was a variation of 2° 95′. This variation went on increasing till a century later—that is, till the ninth century. A professor of geomancy then added a new circle to the compass. On this improved compass the first of the twelve hours begins on the new circle at 7½° east of north.

The compass, it will be observed, grew out of the old astrological report or nativity paper, calculated from the position of the stars, and prepared in the Han dynasty by astrologers as a regular part of social life, especially when marriages were about to be solemnized. Some of the old astronomical circles are preserved in the new geomantic chart. This was the compass used when Shen-kwa wrote on the south-pointing needle in the eleventh century. This author mentions that any iron needle acquires polarity by rubbing it on a piece of loadstone. He alludes to the variation as a fact which he himself had observed, and speaks of the south-pointing needle as an implement used by the professors of geomancy. By them it was employed in the form of a float upon water. After this, in 1122, an ambassador to Corea describes the use of the floating needle on board ship while he made the voyage. This is the first instance, the earliest by more than a century, of the use of the mariner's compass on board ship, found as yet in any book, native or foreign. The existence of the book in which this is recorded settles the question of the first use of the mariner's compass at sea in favour of the Chinese. At that time the needle floated on water supported on a piece of wood, but in the Ming dynasty some Japanese junks engaged in piracy were captured by the Chinese, and the compass in use on board was found to have the needle dry and raised on a pivot, while still pointing southward. The Japanese had learned from the Portuguese navigators to make a compass of this kind, and probably the needles they used were brought from Europe. From this time, the Chinese adopted the principle of a pivot, and made their compasses without a well of water in the middle to float the needle in. Charts were probably used of a very rough kind, but how far is not known. What is known is that the junk-master was aware of the direction in which the needle must point to reach the port to which he was going. In the Sung dynasty, embracing part of the tenth, as well as the eleventh, twelfth, and part of the thirteenth centuries, Chinese junks went to Persia and India. The Arabs trading to China directly would learn at that time the use of the compass, and would apply it on board their dhows. From them the Europeans learned this useful invention.

The credit of the discovery, both of the polarity of a magnetized needle and its suitability for use by mariners at sea must therefore, according to this writer, be given to the Chinese. It was China also that has the credit of having first noticed that any iron needle may be polarized by rubbing it with a magnet, In the thirteenth century the Arabs used a floating compass on their dhows. The needle was made to float on the water by attaching it crosswise to a cornstick or splinter of wood. A magnet applied to it drew it into a north and south direction. They would use Western notation to mark the quarters and intermediate points on the horizon. When therefore the mariner's compass was adopted from them, the Chinese 24 points were not communicated. In the European compass the notation of 32 points is Western, and rests on the winds and the sun. In the Chinese primitive mariner's compass the notation is that of the professors of geomancy, and rests on the old astrological division of the horizon into twelve double hours. From the Arab account we learn, what the Chinese accounts do not tell us, that the Chinese floated the needle by inserting it in a splinter of wood.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ROYAL COLLEGE OF SCIENCE.—The following scholarships, prizes, and Associateships have been awarded for the session 1890–91:—First year's scholarships to William Allan, Thomas T. Bedford, Edwin Edser, and Herbert A. Clark; second year's scholarships to John W. Pickles and Sydney Whalley; the Edward Forbes Medal and prize of books for biology to Arthur G. Butler; the Murchison Medal and prize of books for geology to Charles G. Cullis; a Tyndall prize of books for physics, Course I., to William Allan; the De la Beche Medal for mining to James G. Lawn; the Bessemer Medal and prize of books for metallurgy to Joseph Jefferson; the Frank Hatton prizes of books for chemistry to Herbert Grime and Lionel M. Jones. Prizes of books have been given by the Department of Science and Art in the following subjects:—Mechanics—Charles H. Kilby, Charles P. Butler, Herbert A. Clark. Astronomical Physics—Lawrence Parry and Samuel S. Richardson. Practical Chemistry—William A. C. Rogers. Mining—James G. Lawn. Principles of Agriculture and Agricultural Chemistry—Henry Wilkinson. Associateships of the Royal College of Science have been awarded as follows:—Mechanics—1st class, Harold Busbridge and Ernest W. Rees; 2nd class, Angus Leitch. Physics—1st class, Sidney Wood; 2nd class, William Shackleton and Alfred B. Lishman. Chemistry—1st class, Herbert Grime, Lionel M. Jones, Alfred Greeves, William A. C. Rogers, and Morton Ware; 2nd class, John G. Saltmarsh. Biology (Zoology)—1st class, Arthur G. Butler and James Harrison. Geology—1st class, William J. Smeeth. The following Associateships, Royal School of Mines, have also been awarded:—Metallurgy—1st class, Joseph Jefferson, Alfred Stansfield, John Eustice, and William F. P. Tindall; 2nd class, John D. Crabtree, Thomas S. Fraser, Henry T. Bolton, Benjamin Young, Hugh F. Kirkpatrick-Picard, George J. Snelus, James R. Crum, and Stanley H. Ford. Mining—1st class, James G. Lawn, John Yates, Robert Pill, Theodore G. Chambers, Algernon P. Del Mar, Nono Kitto, and George R. Thompson; 2nd class, Reginald Pawle, Charles C. Scott, Henry Cavendish, Gustave Busch, George H. Gough, and Ben Howe.

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for June contains:—An account of the meeting of the New England Meteorological Society on April 18 last. The subject of discussion was weather predicting. The general methods of predicting in the United States and Europe were first described, and afterwards local and long-range predictions were considered. Papers were read by J. Warren Smith, on the Signal Service weather forecasts; W. M. Davis, on European weather predictions; A. L. Rotch, on

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the local weather predictions of the Blue Hill Observatory; M. W. Harrington, on weather prediction in the States and its improvement, together with several other similar papers.—The zodiacal light as related to the aurora, by O. T. Sherman. The author gives tables and curves constructed from a large number of observations, showing (1) the relative elongation of the zodiacal light, from observations taken in March, from 1801–86; (2) corrections to the earth's calculated longitude, being that part of the amount by which the observed position varied from the calculated, which is probably due to zodiacal light; (3) Fritz's auroral numbers for Europe south of the polar circle; and (4) his relative numbers for Europe. The conclusions drawn from the tables are that from 1806–27 there was no observation of the zodiacal light, slight and irregular variation of the earth's motion, and slight and irregular auroras. For the next fifty years each period of elongation of the zodiacal light corresponded with a maximum acceleration of the earth's motion, and a minimum in the aurora. And further, that at the time when the zodiacal light was beyond the earth's orbit, the auroras were few and diminished in number.—Farwell's rainfall scheme. This article (which is unsigned) states that Senator Farwell carried a Bill through the last session of Congress, for testing the possibility of the artificial production of rain by means of explosions. The experiments, which are soon to be tried, are intrusted to the Agricultural Department; the officials, however, are said to have little confidence in the success of the experiment. Mr. Fernow, Chief of the Division of Forestry, gives a long report upon the proposal, together with a summary of the literature of the subject.

American Journal of Science, July.—The solar corona, an instance of the Newtonian potential function in the case of repulsion, by Prof. Frank H. Bigelow. This is a continuation of the author's researches into the laws which regulate the development of the various coronal forms.—Newtonite and rectorite, two new minerals of the kaolinite group, by R. N. Brackett and J. Francis Williams. Taking the composition of kaolin as $Al_2O_3,2SiO_2,2H_2O$, the following series of hydrous silicates of alumina may be derived by eliminating or introducing a molecule of water:—

	Percentage Composition.		
	Al_2O_3	SiO_2	H_2O
(1) Al_2O_3, $2SiO_2$, H_2O	42·52	49·99	7·49
(2) Al_2O_3, $2SiO_2$, $2H_2O$	39·57	46·56	13·93
(3) Al_2O_3, $2SiO_2$, $3H_2O$	36·98	43·47	19·55
(4) Al_2O_3, $2SiO_2$, $4H_2O$	34·72	40·82	24·46

From the facts and considerations stated in the present paper it appears probable that three members are known out of the four in the above series, viz. (1) rectorite, (2) kaolin and members of the kaolinite group, and (4) newtonite.—On the intensity of sound; ii. the energy used by organ-pipes, by Charles K. Wead. From the results of experiments with different organ-stops out, it appears that no exact conclusion can be drawn from the loudness of the sound as to the relative quantity of wind required to blow pipes of different construction; thus, the soft Dulciana stop of the organ upon which the experiments were performed took more than half as much wind as the comparatively loud Open Diapason, whilst the pipes of the Trumpet stop required less energy than any others sounding the same note. The results obtained in the case of different pipes of the same stop indicate that the volume of air used per second, and therefore the energy expended per second, varies as the $\frac{3}{4}$-power of the wave-length of the note, or inversely as the $\frac{3}{4}$-power of the vibration-ratio.—New analyses of astrophyllite and tscheffkinite, by L. E. Eakins. The analyses give $R''_4R'_4Si(SiO_4)_4$ as the general formula for astrophyllite. This agrees with that found by Brögger from a discussion of analyses by Bäckström and König. Tscheffkinite does not appear to be a mineral in any strict construction of the word, but merely a mixture.—The minerals in hollow spherulites of rhyolite from Glade Creek, Wyoming, by J. P. Iddings and S. L. Penfield. The authors find that in the rhyolite investigated fayalite occurs in association with abundant quartz of a peculiar development, as the result of the mineralizing action of vapours in the cooling acid lava. In certain hollow spherulites the fayalite is replaced by hornblende and biotite.—Bernardinite: is it a mineral or a fungus?, by Joseph Stanley Brown. From Mr. Brown's examination it appears that the mineral resin from San Bernardino County, California, described by Prof. Stillman in the *American Journal* twelve years ago, is the fungus *Polyporus officinalis*, Fries.—Development of Bilobites, by Dr. Charles E. Beecher.—Gmelinite from Nova Scotia, by Louis V. Pirsson. The optical characters, cleavage, and chemical composition of this mineral have been studied. The result of the crystallographic work points to a distinct difference between it and chabazite, but with regard to twinning and chemical constitution the two appear to be identical. Indeed, gmelinite seems to bear much the same relation to chabazite that enstatite does to hypersthene.—Analyses of *kamacite*, *tænite*, and plessite from the Welland meteoric iron, by John M. Davidson. The conclusion is arrived at that in the Welland siderolite only two distinct nickel-iron alloys occur, viz. *kamacite* and *tænite*, and that the so-called plessite is merely thin alternating lamellæ of the two.

American Journal of Mathematics, vol. xiii., No. 4.—In this number J. Perrott's "Remarque au sujet du théorème d'Euclide sur l'infinité du nombre des nombres premiers" is continued from No. 3, and concluded; the author promising a further article on "L'application du procédé du géomètre grec à d'autres cas de la proposition de Lejeune Dirichlet."—The following papers also appear:—Ether squirts, by Karl Pearson, an attempt to specialize the form of ether motion which forms an atom. The main portion of the paper is devoted to an investigation of inter-atomic and inter-molecular forces.—On the matrix which represents a vector, by C. H. Chapman. The fundamental idea is that the linear and vector function of a vector is simply the matrix of the third order.—Sur une forme nouvelle de l'équation modulaire du huitième dégré, par F. Brioschi.—The index to vol. xiii. is appended to this number, which concludes it.

SOCIETIES AND ACADEMIES.

Edinburgh.

Royal Society, July 6.—The Hon. Lord McLaren, Vice-President, in the chair.—Mr. John Aitken read a paper on the solid and liquid particles in clouds (see p. 279, July 23).—Prof. Tait communicated a paper by Prof. Chrystal on a demonstration of Lagrange's rule for the solution of the linear partial differential equation, with some historical remarks on defective demonstrations hitherto current. Prof. Chrystal's proof is purely analytical. Prof. Tait remarked that, on quaternionic principles, the problem may be regarded as follows. Let the equation be

$$Pp + Qq = R,$$

where P, Q, and R, are given functions of x, y, and z, and p, q, represent respectively the quantities dz/dx, dz/dy. By the introduction of a new variable, u, this may be put into the form

$$P\frac{du}{dx} + Q\frac{du}{dy} + R\frac{du}{dz} = 0.$$

But du/dx, du/dy, du/dz, are proportional to the direction cosines of the normal to the surface $u = c$, and therefore P, Q, R are proportional to the direction cosines of a tangent line to $u = c$. Hence we deduce, as the equations of a curve which lies wholly on the surface,

$$\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}.$$

The integrals of these equations are known to have the form $v = \alpha$, $w = \beta$, where α and β are arbitrary constants. The intersections of these surfaces fill space with a set of lines, and the problem is to find a single general set of surfaces upon which these lines will lie. Their equation is $v = f(w)$, where f is an arbitrary function. It is therefore the integral of the given differential equation.—Prof. Tait read the fifth part of his paper on the foundations of the kinetic theory of gases. He has applied his expresson for the isothermals of a liquid and its vapour to the case of ethyl oxide. The results are in remarkable accordance with the direct observations of Drs. Ramsay and Young. He has also applied the virial method to systems of doublets, triplets, &c. The close correspondence of the results calculated from his formula with Andrews's and Amagat's observations on carbonic acid was somewhat surprising when it was considered that the theoretical results were deduced on the assumption of smooth, hard, spherical molecules, while the molecule of carbonic acid is very complex. In the present part of his paper, Prof. Tait shows that, from the manner in which the (approximate) virial equation is formed, no term depending on internal actions in molecules themselves can appear in it when the number of molecules is sufficiently large. He also discusses the mechanism of equilibrium between liquid and

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